



Evaluation of presence (and immersion) in VR

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Presence and Immersion

- Presence and immersion are different constructs [Regebrecht, 2001, 1999; Lessiter 2000] with a complex relationship [Slater and Steed, 2000a]

Presence

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 - a multi-dimensional construct
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 - a multi-dimensional construct
 - ▶ there is no standard recognized definition for presence
- Current status [Youngblut, 2003]:
 - unverified assumption: higher sense of presence in a VE = better performance
 - no comprehensive established theory of presence [Schuemie et al. 2001; Draper, Kaber, and Usher 1998; Riva, Davide, and Ijsselsteijn 2003]
 - no agreement on how presence should be measured
 - ▶ over 70 different measures, over 100 experimental studies

Definition of Presence

- Presence as **spatial presence (or place presence)**
 - a person's sense of physical location, that "of being" in a particular place
 - the subjective experience of being in one place or environment, even when one is physically situated in another place or environment



Definition of Presence

- Additional types of presence:
 - **co-presence**: the subjective experience of being together with others in a computer-generated environment, even when participants are physically situated in different sites [Youngblut, 2003]
 - **social presence**: the degree to which a user feels access to the intelligence, intentions, and sensory impressions of another [Bicocca 1997]
 - ▶ Active research topic in the context of computer-mediated communications [Short, Williams, and Christie 1972]
 - **object presence** (for augmented reality): the subjective experience that a particular object exists in a user's environment, even when that object does not [Stevens et al. 2002]



Immersion

- Immersion is:
 - a description of the VE technology used
 - a precondition of presence, depending on a participant's perception and reaction to a VE [Singer and Witmer 1999]

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- Immersion is:
 - a description of the VE technology used
 - a precondition of presence, depending on a participant's perception and reaction to a VE [Singer and Witmer 1999]
 - ▶ it describes the extent to which the computer displays are capable of delivering an illusion of reality to the senses of a human participant that is [Slater and Wilbur 1997]:
 - ✓ inclusive: indicates the extent to which physical reality is shut out
 - ✓ extensive: indicates the range of sensory modalities accommodated
 - ✓ surrounding: indicates the extent to which this VR is panoramic rather than limited to a narrow field
 - ✓ vivid: indicates the resolution, fidelity, and variety of energy simulated within a particular modality (for example, visual and colour resolution); it is concerned with the richness, information content, resolution and quality of the displays

Measure attributes

- The **ideal measure** should be:

- ✓ non intrusive
- ✓ free from participant or experimenter bias
- ✓ easy to use
- ✓ capable of measuring temporal variations in the construct being measured



- ✓ **reliable**
 - dependent only on the construct being assessed
 - it produces repeatable results under equivalent circumstances
- ✓ **valid**
 - it measures what it purports to measure and nothing else
 - it varies in expected ways with related variables or constructs and, conversely, is stable with respect to unrelated variables
- ✓ **sensitive**
 - capable of detecting any change in the construct being measured, i.e, it can measure an effect caused by manipulating a variable known to influence that construct.
- ✓ **able to remain constant when its determinants covary in compensating ways [Ellis, 1996]**

Measures of Presence

- An ultimate measure of presence will be an aggregate of different components, for example, subjective and observed behavioral measures
 - Depending on the application, may address multiple types of presence

Measures of Presence

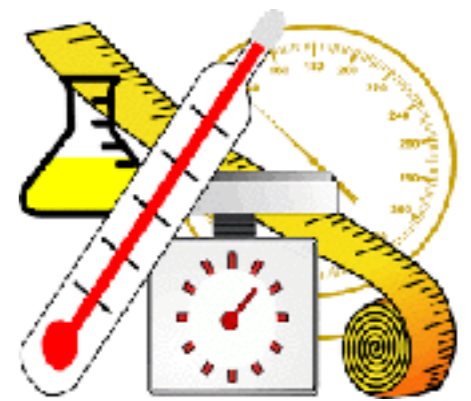
- **Subjective measures:** rely on some type of participant self-report or scaling of a sensory experience
 - ✓ questionnaires
 - focusing on perceptual and/or physiological responses to technological characteristics
 - focusing on cognitive aspects
 - ✓ measures based on discriminating between environments
 - ✓ measures based on assessment of psychological factors



Measures of Presence

- **Objective measures:** involve some form of observation or automated measurement of a participant's behavioral responses to a virtual experience

- ✓ measures based on physiological changes
- ✓ measures that consider reactions such as reflex and socially conditioned responses
- ✓ measures that consider post-interaction effects



Presence Questionnaires [Youngblut, 2003]

	Questionnaire name	Factor Analysis	Item Description	#Studies	Primary Reference
1	Igroup Presence Questionnaire (IPQ)	Yes	1 item assessing the general sense of “being there” and presence subscales: - Spatial Presence (5 items): Sense of being physically presence in the VE - Involvement (4 items): Attention devoted to the VE and the involvement experience - Experienced Realness (3 items): Subjective experience of realism in the VE 5 additional subscales: Interface Awareness, Exploration of VE, Predictability and Immersion, Quality of Immersion, Drama	3	[Schubert 2001]
2	ITC Sense of Presence Inventory (SOPI) → used only for IMAX cinema, 3D TV, and video games	Yes	44 items, with subscales: - Spatial Presence (19 items): Sense of physical presence placement, and interaction and control over parts of the mediated environment - Engagement (13 items): Tendency to feel psychologically involved and enjoy the content - Ecological Validity/Naturalness (5 items): Tendency to perceived mediated environment as lifelike and real - Negative Effects (6 items): Tendency to feel adverse physiological reactions.	1	[Lessiter 2001]
3	Memory Characteristic Questionnaire (MCQ)	No	21 items, including several related to metamemory judgments concerning presence. Other items address qualitative differences between experiences in memory, attention, coherence of memories, FOV, and similarity among environments.	1	[Hullfish 1996]
4	Object Presence Questionnaire (OPQ)	Yes	32-item version of Witmer-Singer PQ, modified to reflect sense that an object exists in the participant’s environment , as opposed to the participant “being there.”	1	[Stevens 2002]
5	Questionnaire VR	No	22 items, with 3 items related to presence , based on sense of being in the same room as task- related objects and experiencing the VE as a place visited.	2	[Alexelsson 2001]
6	Questionnaire on Presence and Realism	No	2 items, one rating sense of presence and other rating degree of realism .	2	[Weiderhold 2001]
7	Reality Judgment & Presence Questionnaire	Yes	Subscales: - Reality Judgment (8 items): Relating to reality, realism, and presence - Internal/External Correspondence (6 items): Relating to interaction and presence - Attention/Absorption (4 items): Relating to concentration, attention to limited field of stimuli, and loss of a sense of passage of time.	2	[Banos 2000]
8	Slater-Usoh-Steed (SUS) Questionnaire	No	5 to 6 items based on: (1) sense of “being there” in the VE as compared to being in a place in the real world, (2) extent to which there were times when the VE became the dominant reality , and (3) extent to which a participant remembers the VE as a place visited , rather than as having seen computer-generated images.	25	[Slater 1999]
9	Swedish Viewer-User Presence (SVUP)	No	150 items, 18 of which relate to presence covering interaction, awareness of external factors, sound quality, enjoyment, simulator sickness . Remaining items cover quality evaluations, attitudes, realism, and information from different modalities.	1	[Larsson 2001]
10	University College London (UCL) Questionnaire	No	Subscales: - Presence (7 items): Based on SUS Questionnaire - Behavioral Presence (3 items): Feeling of acting as if in similar real world - Ease of Locomotion (3 items): Whether movement was simple, straightforward, and natural	4	[Meehan 2001a]
11	Virtual Presence Questionnaire	No	Sub-questionnairescales: - Virtual Presence: Based on Psootka’s questionnaire - Social virtual presence	1	[Thie 1998]

Presence Questionnaires [Youngblut, 2003]

	Questionnaire name	Factor Analysis	Item Description	#Studies	Primary Reference
12	VR Usability Questionnaire (VRUSE)	Yes	100 items. Includes subscale: - Sense of Immersion/Presence (10 items): Extent to which VR system allowed participant to feel part of or immersed in the VE. Remaining subscales include Functionality, User Input, System Output (Display), Consistency, Flexibility, Simulation Fidelity, and Overall System Usability.	1	[JSC 2000]
13	Witmer-Singer Presence Questionnaire (PQ)	Yes	32 items, with subscales: - Involved/Control (11 items): A ability to control events in the VE and responsiveness - Natural (3 items): Naturalness of interactions and consistency of VE - Interface Quality (3 items): Relating to amount of interference or distraction from task performance and participant's ability to concentrate Additional subscales retained on theoretical basis, not yet used: Auditory, Haptic, Resolution	32	[Witmer 1994a]
14	-	Yes	Factors: - Sense of "being there" (1 item) - Engagement of human senses (5 items): Awareness of real world and completeness of visual, auditory, and tactile sensory engagement - Perceived fidelity of interaction (12 items): Impact of input device, ease of movement, comfort level, realistic depth portrayal, and enjoyment.	2	[Barfield 1998]
15	-	Yes	Factors: - Spatial Presence (10 items) - Tactile Engagement (3 items) - Sensory Presence (3 items)	1	[Bicocca 2001a]
16	-	Yes	15 items, with presence subscales: (remaining items related to co-presence) - Presence in VE (3 items): Extent to which participant is psychologically engaged - Quality of VE (2 items): Extent of participant's presence in the VE and realism of the spatial transformation perceived by the participant - Task Difficulty (1 item): Difficulty of performing task.	1	[Bystrom 1999]
17	-	No	4 items rating visual realism of objects, ability to perceive self/object locations, visual realism of overall environment, feeling on being in the environment.	1	[Cho 2003]
18	-	-	1 item related to presence, repeated for different types of display devices. Remaining items designed to capture information comparing visual display devices.	1	[Deisinger 2001]
19	-	No	14 items related to presence , 4 items related to spatial layout , 5 items on object location	1	[Dinh 1999]
20	-	Yes	2 items querying presence , 9 items relating to realism as affected by stereopsis, head tracking, GFOV	3	[Hendrix 1996a]
21	-	-	7 visual analog scales from 0–100, including: extent participant felt he went into the virtual world, extent virtual world seemed like place seen or visited, and extent participant felt he was standing in a laboratory or in the virtual world.	3	[Hoffman 1999]
22	→ used only for IMAX cinema, 3D TV, and video games	Yes	Dimensions: - Immersion : Sense of immersion, involvement, and engagement - Parasocial Interaction : Concerned with moving between real and virtual environments - Parasocial Relationships : Concerned with feelings of friendship toward participants - Physiological Response : Concerned with physiological reactions - Social Reality : Concerned with comparisons on how virtual events might occur in reality - Interpersonal Social Richness : Ability to observe interpersonal communication cues - General Social Richness : Concerned with items such as impersonal/personal, unemotional/emotional, unresponsive/responsive.	1	[Lombard 2000]

Presence Questionnaires [Youngblut, 2003]

	Questionnaire name	Factor Analysis	Item Description	#Studies	Primary Reference
23	-	Yes	9 items, including 3 rating scales based on the concepts underlying the SUS Questionnaire, and two items related to the ambient environment. Additional items addressed factors that might be related to presence, such as lag.	1	[Nichols 2000]
24	-	No	5 items related to presence, some similar to SUS Questionnaire	3	[Prothero 1995a]
25	-	Yes	21 items on virtual and social presence; earlier 11-item version with factors: <ul style="list-style-type: none"> - Distractibility: Concerned with potential distractors outside the VE - Willingness to Suspend Disbelief: Deal with components or ecological affordances of the environment that control the depth of immersion - Concentration: Concerns effect of others on enjoyment, extent of surprise when HMD removed - Simulation Sickness Effects: Concerned with occurrence of symptoms of nausea, disorientation, and wooziness. Additional items address realism, responsiveness, FOV, ability to visually search, sensory engagement, adaptation, and flashbacks	1	[Psootka 1993]
26	-	No	14-item questionnaire	1	[Regenbrecht 1998]
27	-	No	Items addressing sense of being in the VE, additional items addressing co-presence	2	[Romano 1998]
28	-	Yes	27 items grouped into dimensions: <ul style="list-style-type: none"> - Being there: "Being there" in the VE - Not being there: Concerned with the disappearance of mediation - Reflective Consciousness: Awareness of "being there." 	1	[Sas 2001]
29	-	No	2 items on object presence, 1 item on place presence, 2 items on co-presence	1	[Schroeder 2001]
30	-	No	2 items on place presence	1	[Tromp 1998]
31	-	No	2 items querying sense of being in the same room as objects	1	[Widestrom 200]
32	-	No	2-item questionnaire	1	[wiederhold 1998]

Presence Questionnaires

- Questionnaires:
 - vary considerable in length
 - are usually structured into subscales intended to reflect different components or dimensions of the presence construct
 - use some type of semantic difference or Likert-type (5 to 11-point) scale where each item is anchored by opposing descriptors
 - are scored by summing the item scores
 - ▶ Usually data analysis require the use of nonparametric statistics
- Correlation analysis used to:
 - identify groups of related items (i.e, *factors*)
 - ▶ each factor accounts for a proportion of the variance across all the items
 - provide information about the relative importance of items
 - identify unrelated items for removal
 - provide some indication of the completeness of a set of items (by looking at the total variance accounted for)
- ▶ Ideally, the analysis should be repeated with several unrelated data sets
 - this has occurred for only the IPQ and the Witmer-Singer PQ

More recent works

- Presence, Explicated (2004)
- Being There: The Subjective Experience of Presence (2005)
- Defining Virtual Reality: Dimensions Determining Telepresence (2012)
- Place presence, social presence, co-presence, and satisfaction in virtual worlds (2012)
- A Framework for Assessing Spatial Presence of Omnidirectional Video on Virtual Reality Device (2018)

[and many works consider presence and immersion when there is self-embodiment]

A lot of material!

- Proposal:
 1. to create a joint wiki and bibtek file to collect and review all relevant references
 2. to select common definition and measures
- Extremely valuable resource: “Experience of Presence in Virtual Environments”, C. Youngblut, 2003

Thank you for your attention!

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